Evaluation of Infrared Sky Imagers for the Atmospheric Radiation Measurement Program

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Introduction
Nighttime cloud fraction has been and remains a critical programmatic gap in the US DOE Atmospheric Radiation Measurement (ARM) Program's observational dataset. Infrared sky imaging technology holds great promise in closing this gap and has the advantage that its ability to characterize clouds is identical for both day or night conditions. Therefore, instrument demonstrations were conducted at the ARM Climate Research Facility Southern Great Plains site in 2005, 2007, and 2009 to evaluate measurements of cloud fraction from different types of commercially-available infrared sky imagers.

Background
- Infrared sky imager system installed in October 2005
  - Blue Sky Imaging All Sky Thermal Infrared Camera
  - daytime measurements significantly underestimate those from Total Sky Imager (TSI)
- Infrared Sky Imager (IRSI) Intercomparison Study conducted in September 2007
  - compared measurements from five different types of infrared sky imagers
  - results did not provide a clear solution for obtaining nighttime cloud fraction
- Upgraded All Sky Infrared Visible Analyzer demonstrated in Summer 2009
  - Solmirus Corporation made significant improvements to hardware and retrieval algorithms
  - daytime images and cloud fraction data correlate very well with TSI

Objectives
- Produce nighttime cloud fraction product
- Capture hemispheric infrared images of the sky during both the day and night
- Compare cloud fraction and cloud height data with measurements from an existing IRSI, TSI, Ceirometer, and Micropulse Lidar
- Select instrument for deployment at sites

Instruments Tested
- Blue Sky Imaging All Sky Thermal Infrared Camera (ASTIC)
  - provides hemispheric sky images and cloud fraction at four fields-of-view
- Solmirus All Sky Infrared Visible Analyzer (ASIVA)
  - provides radiometric sky images, cloud percent, cloud/sky temperature, sky opacity, and water vapor determination
- Heitronics Nubiscope
  - provides cloud percent, cloud/sky temperature, cloud height, sky condition, and hemispheric cloud cover representation
- Atmos Cloud Infrared Radiometer (CIR-4)
  - provides cloud percent, cloud/sky temperature, and cloud height

Sky Image Comparison

<table>
<thead>
<tr>
<th>Cloud Fraction</th>
<th>Cloud Height</th>
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<tbody>
<tr>
<td>Bar-plot of 10-minute average absolute difference from TSI of cloud fraction in percent</td>
<td>Bar-plot of 10-minute average absolute difference from ARSCL of cloud height in meters</td>
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</tbody>
</table>

Cloud Fraction

<table>
<thead>
<tr>
<th>TSI</th>
<th>ASTIC</th>
<th>Nubiscope</th>
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<tbody>
<tr>
<td>CF=41%</td>
<td>CF=7%</td>
<td>CF=75%</td>
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<td>Daytime, 9/6/2007 13:41 CDT</td>
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<td>CF=40%</td>
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References